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# A Late Wisconsin Buried Peat Pollen Profile from the Valley Heads Region at South Dansville, New York

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A Late Wisconsin Buried Peat Pollen Profile From The  
Valley Heads Region At South Dansville, New York

By

Theodore S. Rynders

Submitted as partial fulfillment of  
the Masters in Botany program at  
S.U.C. Brockport, N.Y.

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## Preface

There was no indication at the time of collection that the site would prove to be as important a contribution as is now indicated by the radiocarbon date and the profile. The nature of the collection and the impossibility of obtaining additional site material imposed unique conditions on the study.

Stones found in the bottom glacial clay were identified by Dr. R.W. Adams of the Dept. of Geology at S.U.C. Brockport, N.Y. and macrofossil identifications were made by Dr. John Kundt of the Dept. of Biology at S.U.C. Geneseo, N.Y.

Karl P. Pfaff, an employee of the S.U.C. Geneseo, N.Y., noticed the buried peat while his neighbor Arthur Stauffer was bulldozing the site for a farm pond in the summer of 1970. Mr. Pfaff persuaded him to stop bulldozing until the next day while he informed Dr. John Kundt of the Biology Dept. at S.U.C. Geneseo, N.Y. of the find. Dr. Kundt notified Dr. Gehris at Brockport and we left the next morning to collect at the site. Immediately after our collections were taken the site was destroyed and a farm pond was built.

The advice and guidance of my committee, Dr. Delmont Smith, Dr. H. David Hammond and Dr. Clarence Gehris is much appreciated. Special thanks are due to Dr. Gehris, whose ability to relate to a student is unsurpassed.

## Abstract

A peat deposit buried under 100 cm. of clay was discovered 4.25 miles southeast of Dansville, N.Y. The site is located at 1875 feet above sea level just one mile southeast of the Valley Heads Moraine border.

Profile interpretation and carbon date of 15300 B.P. for the bottom of the peat indicate a pre-Valley Heads ice advance in the region with a putative 1000 year interstade between it and the Valley Heads Substage. Spruce pollen maxima are correlated to the pre-Valley Heads and the Valley Heads ice advances while a pine peak represents the Valdres Substage. Migration of plant communities from the unglaciated Appalachian Refugium sixty miles to the southwest and late glacial history of the area are discussed to interpret development of present vegetation.

## Introduction

The preparation and study of a pollen profile is a laborious task. The resulting profile must be interpreted as one of a series of profiles in the area. This study is unique in being the first to have a radiocarbon date preceding the major Valley Heads ice advance. This profile is planned as the first part of a study which is expected to provide a more complete account of periglacial and postglacial plant migration and development in Western New York. Other studies of the macrofossils and the geology of the region are in progress.

## Review of Literature

Cain(1939), Faegri(1956) and Ogden(1965) reviewed general aspects of pollen analysis and provide an overview of the topic. Ogden(1965), among other topics discussed pre- and early- Wisconsin interglacial and interstadial pollen records in Eastern North America. These had a direct bearing on interpretation of the South Dansville pollen profile.

Yeager(1969) provided a summary of pollen studies in New York State. He referred to McCulloch(1939), Deevey(1943), Sheldon(1952), Cox(1959) and Yeager((1969). McCulloch studied Sandy Ridge Bog in Central New York. Deevey worked on Queechey Lake in the southeast corner of the state. Sheldon studied seven bogs in a thirty mile radius of Syracuse. Cox constructed profiles for twelve bogs in Central New York. Yeager analyzed a core from Kennedy's Bog in Mendon Ponds Park southeast of Rochester. McCulloch, Sheldon, and Cox showed complete profiles starting at the bottom with a spruce-fir zone. The Deevey profile was truncated at the bottom and records deposition starting at the pine period. The Yeager profile began at the end of the spruce zone; he records no fir pollen.

Gehris(1971) analyzed a profile from Bergen Swamp near Byron, N.Y. This study alone indicates a definite Valley Heads- Two Creeks- Valders spruce oscillation. A moderate percentage of fir pollen was found.

Kapp(1969) provides keys for identifying pollen and Brown (1964) has assembled pollen preparation techniques.



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## Glacial History

Fairchild(1926) recognized moraine material south of Dansville, N.Y. In 1932 he specifically referred to it as Valley Heads Moraine. MacClintock and Apfel(1944) agreed with this designation. Connally(1961) proposed the Arkport Moraine (Arkport Substage) which he placed between the Valley Heads Moraine (Port Huron Substage) and his Almond Moraine(Kent, Binghamton Substage). The site from which our core was taken is located on Connally's proposed Arkport Moraine. Although Connally's proposed Arkport Moraine is itself fairly well defined its designation as the product of a separate glacial substage is disputed. Muller(personal communication, July 1971) feels its designation is still open to question. The carbon date of 15300 B.P. for the stony glacial bottom clay- sphagnum peat interface gives support to the intermediate position of Connally's Arkport Moraine.

Calkin(1966) presented a chart which helps give time relationships to these moraines and glacial substages. The chart is partially reproduced here as Fig. 1 with Connally's Arkport and Almond Moraines added.

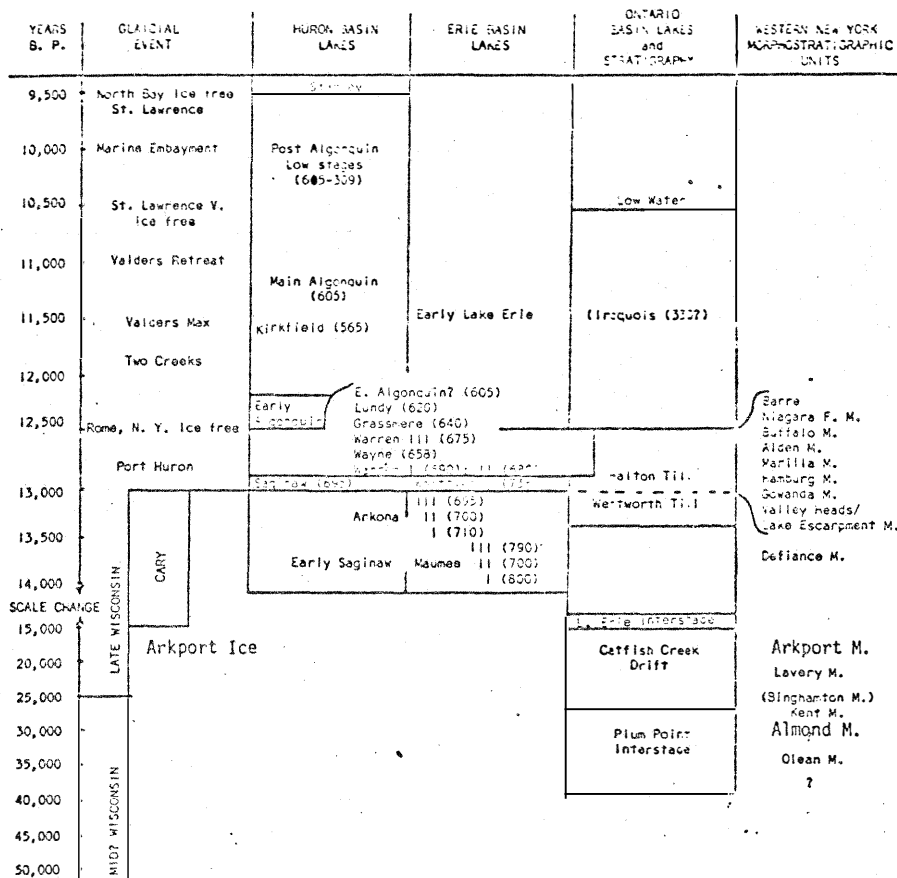


Fig. 1 Glacial Events(Calkin, 1966).

During the Wisconsin glaciation first Olean ice and then Binghamton ice moved over the site. Connally's proposed Arkport ice was the last to directly disturb the area, leaving the depression(possibly a kettle hole) at the site and the stony glacial clay at the bottom. The Port Huron Substage progressed close to but not onto the site depositing the Valley Heads Moraine one mile to the northwest. Much later the Valdres Substage moved into the Erie-Ontario basins affecting the climate but not the topography at the site. The following figures(Fig. 2 and 3) illustrate the relationships of the site to the various moraine deposits.

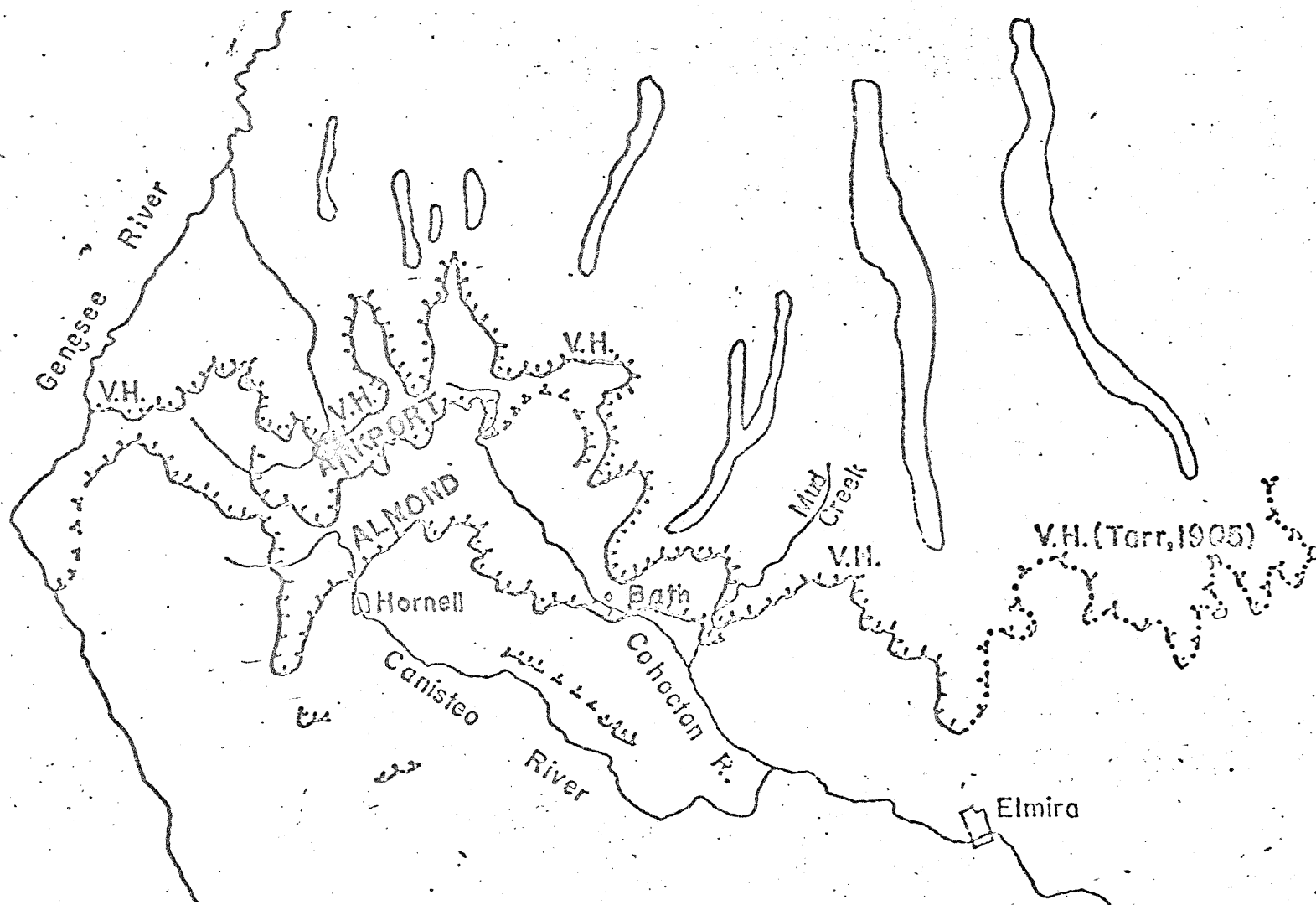


Fig. 2 Finger Lakes Moraines(Connally,1961). Circle and dot mark the site location.

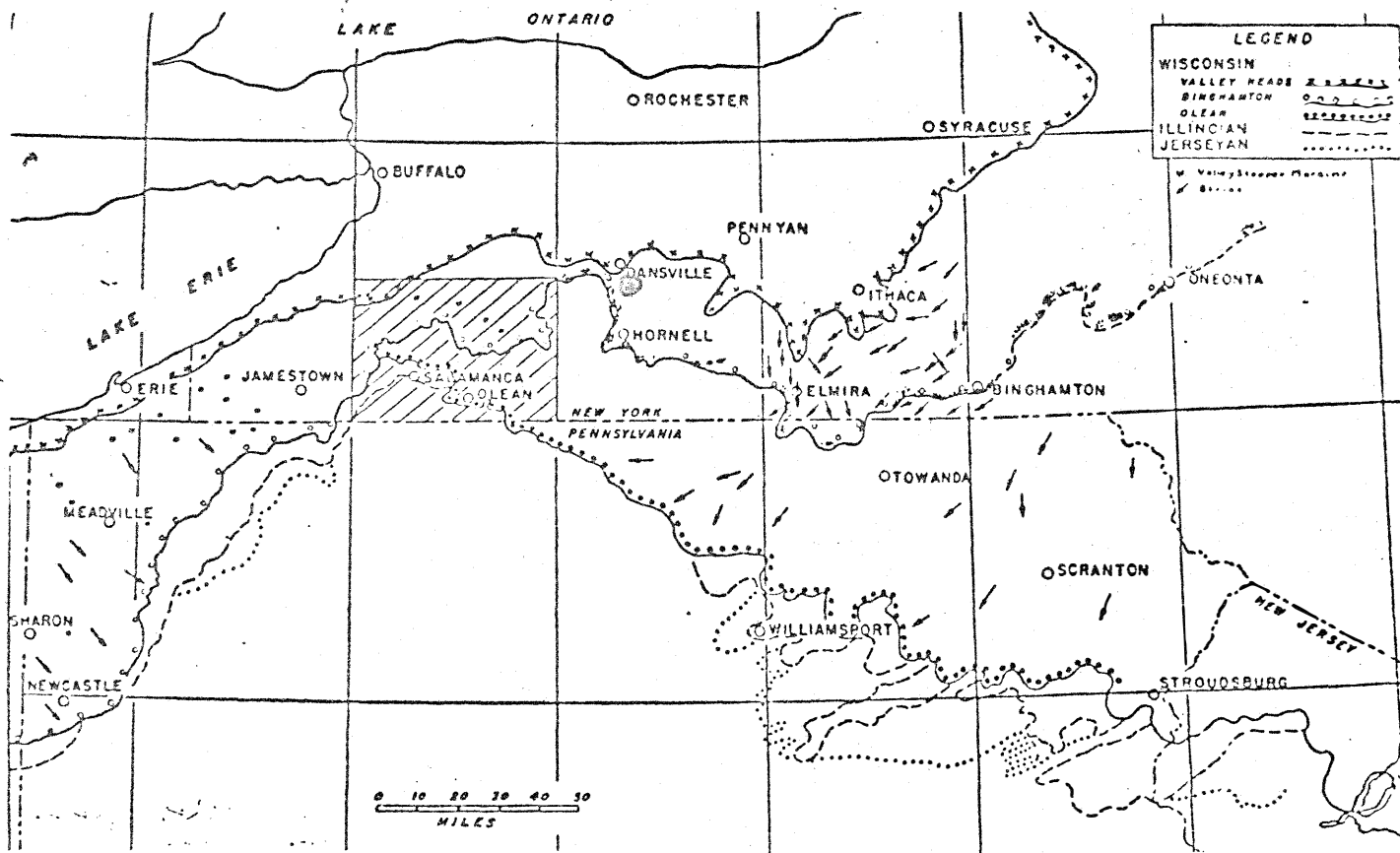


Fig. 3 New York Moraines (MacClintock and Apfel, 1944). Circle and dot mark the site location.

## Present Climate, Vegetation And Soils

Mordoff(1949) provides the following climate information for the area, in map form. January mean temperature:  $-6.5^{\circ}$  to  $-4.0^{\circ}\text{C}$ . ( $20^{\circ}$  to  $25^{\circ}\text{F}$ .), April mean temperature:  $7.3^{\circ}$  to  $10^{\circ}\text{C}$ . ( $45^{\circ}$  to  $50^{\circ}\text{F}$ .), July mean temperature:  $18.3^{\circ}$  to  $21^{\circ}\text{C}$ . ( $65^{\circ}$  to  $70^{\circ}\text{F}$ .), October mean temperature:  $7.3^{\circ}$  to  $10^{\circ}\text{C}$ . ( $45^{\circ}$  to  $50^{\circ}\text{F}$ .), and mean annual precipitation of 76.2 to 101.6 cm. (30 to 40 inches). The climate of this area is classified as a humid continental climate(Critchfield, 1966). The prevailing winds are westerly. The irregular topography of the area results in a variety of microclimates.

Coleman and Ehrle(1969) and Braun(1959) classified the vegetation here as the Allegheny Section of the Northern Appalachian Highland Division of the Hemlock- White Pine- Northern Hardwoods Region. Braun interpreted the vegetation here as a separate formation from the Deciduous Forest and one "whose climax associations are still in a state of flux". Most of the flatter open areas are being utilized for hay production and grazing. The ravines and other less productive lands support second growth woodlands. The site was an open area before bulldozing, being mowed for hay except where wet.

The bedrock is the shale, siltstone and sandstone of the Sonyea Group; being upper Devonian in origin(Broughton et al, 1962). The soil is a calcareous clay and loam mixture. The origin of the material from which the soil was derived is open to question(Muller, 1971). It may or may not be glacial till.

## Site Description

The South Dansville buried peat is located in the northeast corner of the Arkport, N.Y. Quadrangle 7.5 minute series at latitude 42°29'44" North and longitude 77°38'49" West. The site is 1.75 miles NNE. of South Dansville, N.Y. and 4.25 miles SE. of Dansville, N.Y.

The site lies at 1875 feet above sea level on the western side of a steep hill which reaches to 2100 feet. Drainage is west into Stony Brook which flows NW. into Canaseraga Creek, eventually joining the Genesee system to the north flowing into Lake Ontario. The site was a wet area in an open field on a steep hillside.

## Collection And Sampling

The site was partially bulldozed exposing the layered material in a clean vertical cut. A gasoline powered water pump was used to remove water from the depression while sampling. A trowel, meter stick and clean plastic bottles with screw tops were used in sampling. Field contamination was negligible because samples were taken from an inner surface and exposed to air only long enough to be transferred to plastic bottles. Formaldehyde-acetic-acid-alcohol was added on return to the laboratory to prevent fungal and bacterial growth.



### Laboratory Preparation

The samples were processed through 10% HCl to remove marl ( $\text{CaCO}_3$  and  $\text{MgCO}_3$ ). All samples were then prepared by the standard technique of boiling in 10% KOH to deflocculate or loosen the pollen from the surrounding material. All samples were left in 53% HF overnight to dissolve mineral matter. The pollen containing material was stained with 1.0% Safranin O stain and glycerine jelly slides were made in the following manner. Each slide was placed on the warming tray; a small amount of solid glycerine jelly was put on the slide. After the jelly melted the pollen containing material was stirred into it and a coverslip was placed on top. On removal from the warming tray the mounting medium hardened. Pine pollen controls run at the same time showed little fragmentation.

Samples 17- 20 were found to contain insufficient amounts of pollen and were rerun through the above processes in larger amounts. Differential flotation in a bromoform acetone mixture having a density of 2.0g./cc. was then used to concentrate pollen in these samples. Very little pollen was found in spite of these procedures. Acetolysis, a process which removes the cell contents from pollen grains, was not used because the pollen was well fossilized.

After a slide was prepared from processed material taken from a particular level, each kind of pollen was identified and counted. If a pollen grain could not be initially identified the coordinates of the grain were noted and it was studied later.

Arboreal pollen percentages were used to construct a pollen profile(Fig. 5). Percentages were calculated by dividing the number of pollen grains of a particular species by the total pollen grains on the slide and multiplying by 100. Percentages were rounded to whole numbers so the sum of percentages at a level may not equal 100%.

An American Optical Fifty Microscope with calibrated mechanical stage was used. A 43 power objective with 10 power calibrated oculars was used for scanning, noting coordinates, and identifying. Critical examinations were made with 43 power objective and 20 power oculars.

### Results

The Gross Core Description(Fig. 4) was put together from the field notes, stone identifications by Adams(1971),and the macrofossil identifications of Kundt(1971). Samples from the open cut were taken at arbitrary intervals of 10 cm. except at the top where one sample was taken for the first 20 cm.

The Pollen Counts(Table 1) were made by counting grains on a slide made from each level. Pollen percentages are figured from this table.

The Pollen Percentages(Fig. 5a and 5b) were the main tool in interpreting the forest development.

Pollen Percentage Changes are a textural account of percentages figured for each level.

Level Number		Depth Below Surface(cm.)	Description
1		0- 20	Loam- less marl than in other layers .
2		20- 30	Loam/light gray clay.
3		30- 40	
4		40- 50	Light gray clay- marl present, no peat of any kind, fine grained green sandstone present, bits of wood, quite plastic.
5		50- 60	
6		60- 70	Light gray clay/dark gray clay.
7		70- 80	
8		80- 90	Dark gray clay- high sedge peat content, marl and fine grained green sandstone present, marl present, bits of wood,
9		90- 100	
10		100- 110	
11		110- 120	Dark gray clay/sphagnum peat.
12		120- 130	
13		130- 140	Sphagnum peat- no marl, no clay, no stones, white spruce cones, bits of wood, some was oak.
14		140- 150	
15		150- 160	
16		160- 170	Sphagnum peat/blue gray clay.
17		170- 180	
18		180- 190	
19		190- 200	Blue gray clay- stiff, high concentration of marl, fine grained green sandstone.
20		200- 210	

Fig. 4 Gross Core Description

Level number	Depth (cm.) below surface	Acer- maple	Alnus- alder	Betula- birch	Carya- hickory	Castanea- chestnut	Juglans- walnut	Larix- larch	Picea- spruce	Pinus- pine	Populus- poplar, aspen	Quercus- oak	Salix- willow	Tilia- basswood	Tsuga- hemlock	Ulmus- elm	Total Arboreal Pollen	Ambrosia- ragweed	Chenopodiaceae- goosefoot family	Compositae- other composites	Cupressaceae- cedar family	Cyperaceae- bulrush family	Gramineae- grass family	Nymphaeaceae- water lily family	Ranunculaceae- buttercup family	Saxifragaceae- saxifrage family	Total Nonarboreal Pollen
1	0- 20	36								18		69		3	6		137	72	15								91
2	20- 30	36								6		85					127	60	7								71
3	30- 40	14								38		52		4			108	15	6								25
4	40- 50	24								81		27			24		156	6	9								26
5	50- 60	7		2	5			1		109		30		3	15		172	3	3								7
6	60- 70	16		4					1	80		32		2	18		153										5
7	70- 80	28			4				2	48		61		8	28		179		7								12
8	80- 90	31		2	1		5			29		67	1	6	39		181	1	1							1	7
9	90- 100	44		1		2				26	1	29			22		125			1	1						13
10	100- 110	29		3	3	3			8	117		36			14	1	214										3
11	110- 120	20	1						15	54		42			20		152										4
12	120- 130								107	13		19					139	1									10
13	130- 140	13							65	14	17	33					143		1								36
14	140- 150								42	8	42	31			1		123		4			31	3	1			31
15	150- 160	5							102	16	25	16					164		6			25	2				50
16	160- 170	3							105	7	14	14	1				144	1	13			35	8		1		96
17	170- 180									1							1					54	25		3		2
18	180- 190																					2					
19	190- 200																										
20	200- 210																										

Table 1 Pollen Counts

# South Dansville Buried Peat Pollen Profile

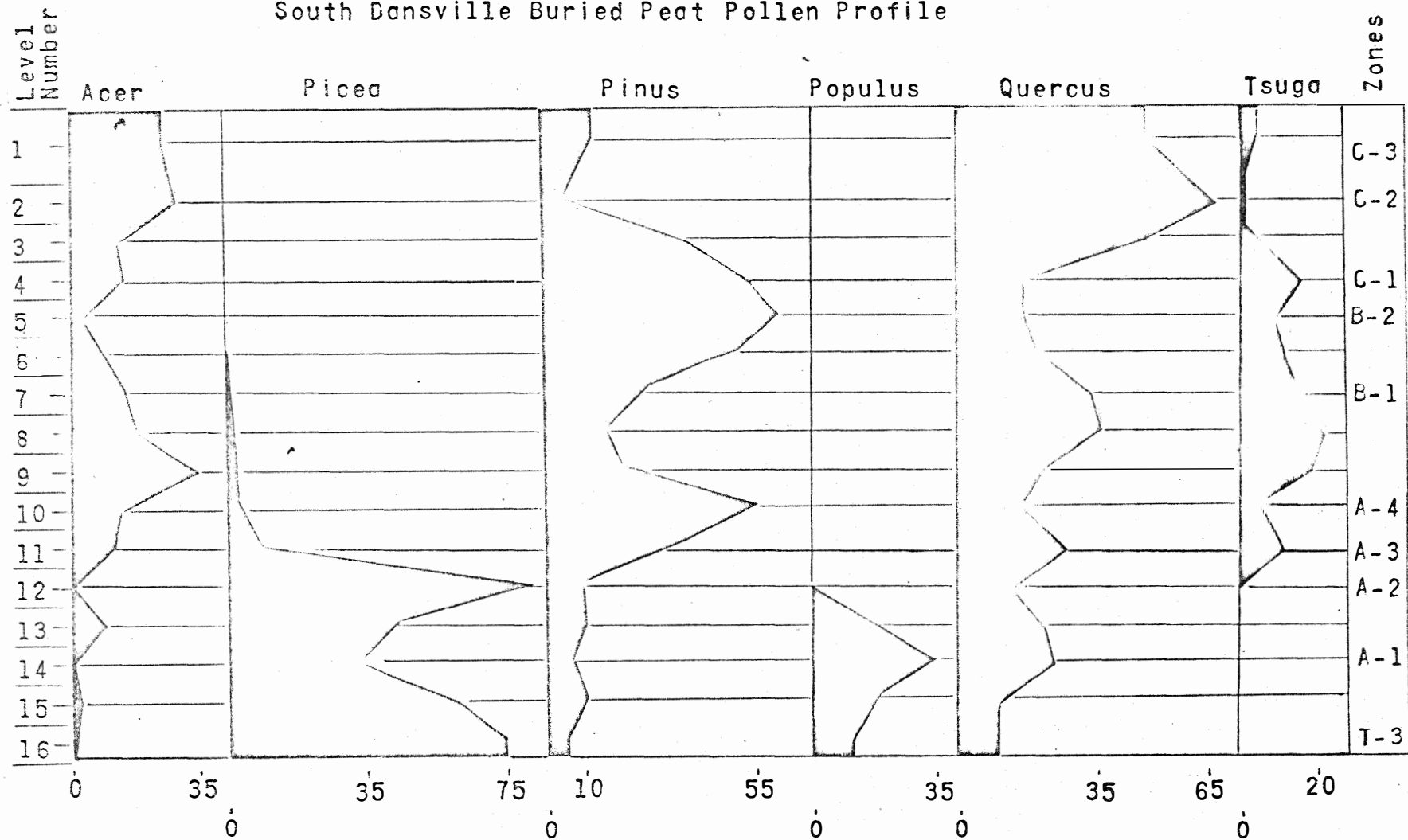


Fig. 5a Pollen Percentages

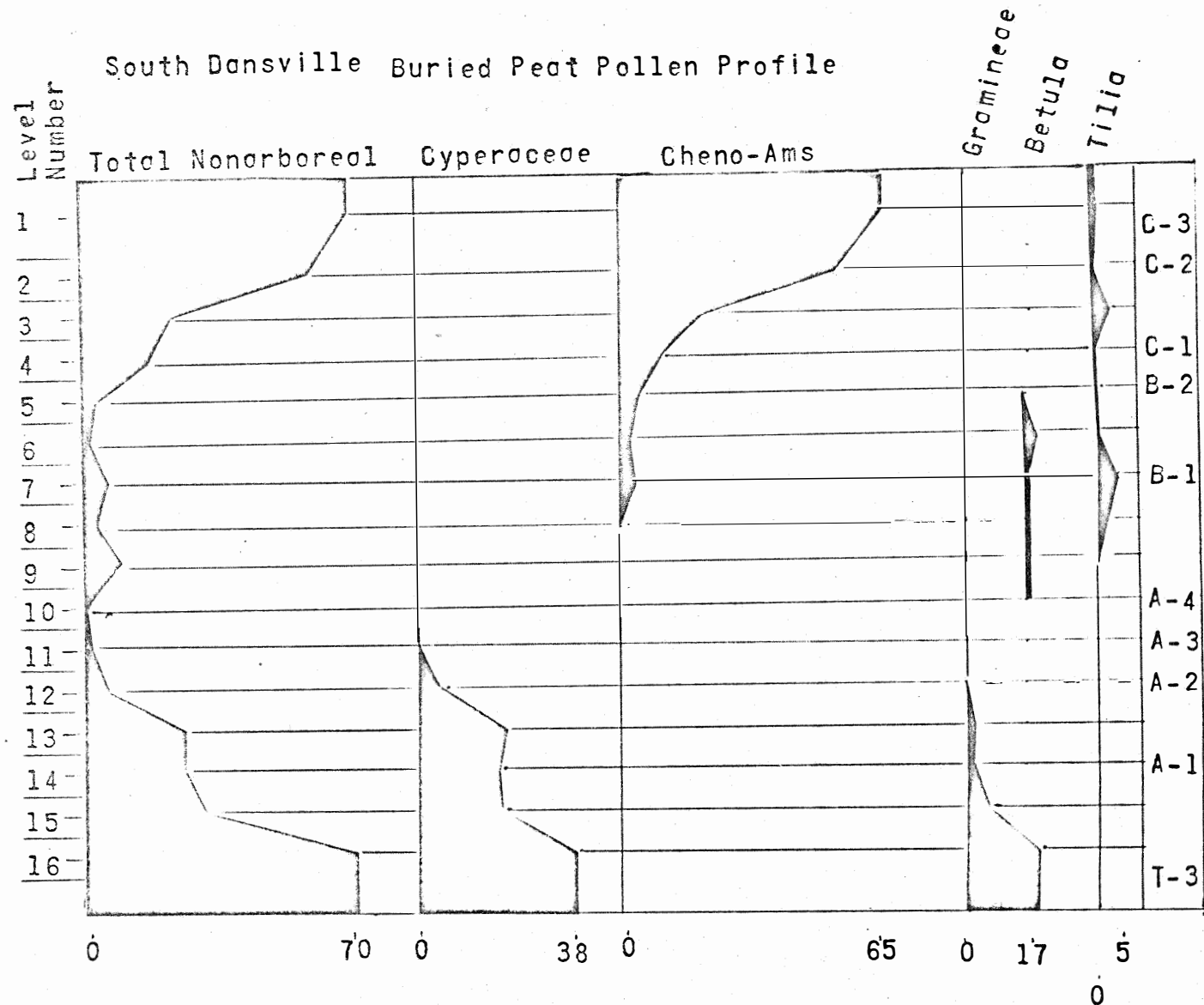


Fig. 5b Pollen Percentages

## Pollen Percentage Changes

Level 17- 20. Almost no pollen was retrieved from the sediments, even with bromoform flotation.

Level 16. Here white spruce(Picea glauca(Moench.)Voss.) was the major pollen contributor(75%). Poplar(Populus L.) and oak(Quercus L.) each contributed 10% of the pollen. Jack pine(Pinus banksiana Lamb.) contributed 5% and a few maple (Acer L.) grains were found. This level had a high nonarbooreal content. Material from level 16 was radiocarbon dated at 15300<sup>±</sup> 190 B.P. by the Westwood Laboratories, Westwood, New Jersey.

Level 15. White spruce pollen decreased to 60%, jack pine increased to 10%, poplar increased to 15%, oak remained at 10% and maple still remained at less than 5%.

Level 14. White spruce pollen reached a minimum of 35%, jack pine decreased to 7%, poplar reached a maximum of 35%, oak increased to a maximum of 25% and maple pollen was nonexistent.

Level 13. White spruce increased to 45%, jack pine increased to 10%, poplar decreased to 10%, oak decreased to 22% and maple increased to 10%.

Level 12. White spruce reached a maximum of 76%, jack pine remained at 10%, poplar was nonexistent, oak was at a minimum of 15% and maple was nonexistent.

Level 11. White spruce pollen decreased to 10%, mixed jack pine and white pine(Pinus strobus L.) increased to 35%, hemlock (Tsuga(Endl.)Carr.) first appeared at 10%, maple increased to 13% and oak increased to 28%.

Level 10. White spruce pollen decreased to 4%, mixed jack pine and white pine were at a maximum of 55%, hemlock decreased to 6%, maple increased to 15% and oak decreased to a minimum of 17%.

Level 9. White spruce pollen was at 3%, white pine was at 20%, hemlock increased to 18%, maple reached a maximum of 35% and oak increased to 23%.

Level 8. White spruce pollen was at 2%, white pine was at a minimum of 15%, hemlock reached a maximum of 22%, maple decreased to 18% and oak was at 37%.

Level 7. Only a few white spruce grains were present, white pine increased to 27%, hemlock decreased to 15%, maple decreased slightly to 16% and oak decreased slightly to 35%.

Level 6. Only one grain of white spruce was seen, white pine increased to 52%, hemlock was at 12%, maple decreased to 10% and oak decreased to 20%.

Level 5. White pine was at a peak of 65%, hemlock was at a 10% minimum, maple reached a minimum of 4% and oak was at a minimum of 17%.

Level 4. White pine decreased to 50%, hemlock was at a 15% maximum, maple leveled off at 15% and oak was still at 17%.

Level 3. White pine decreased further to 35%, hemlock was nonexistent, maple was at 13% and oak increased to 48%.

Level 2. White pine was at a 5% minimum, hemlock was nonexistent, maple was at a 30% peak and oak was at a 67% maximum.



Level 1. White pine increased to 13%, hemlock increased to 5%, maple decreased to 25% and oak decreased to 50%. This level had a high nonarboreal content.

## Discussion

### General Remarks

Pollen percentages at a given level do not directly reflect forest composition. This problem was discussed by Davis(1963). There were many sources of error inherent in the formation of correction formulae. The correction formulae of Davis(1963) have not been developed to the point where they are directly applicable to this study.

Changes in pollen percentages for a given species, from level to level, do reflect proportional changes in forest composition if the effects of differential pollen preservation (Sangster and Dale, 1961) and the effects of wind blown pollen contamination are negligible.

Deevey(1943) felt that only general trends in plant succession could be illustrated by pollen profiles. Deevey thought that counting 150 pollen grains of the arboreal type per level was sufficient to show these general trends and that counting 60 grains per level is often sufficient. Nearly 150 arboreal pollen grains were counted at each level.

Determination of regional vegetation trends can only be found by studying many profiles from a region. Only in this

way can localized effects be eliminated. This profile shows those community trends which occurred at the local site and are not necessarily reflective of regional trends although regional trends may be implied by me. Arboreal pollen is the basic tool for interpretation because in the northeast tree communities usually are the communities that reach climax. Additional studies to interpret regional migration are planned

Deevey(1943) recognized recurring trends in pollen profiles from northeastern United States. Deevey also recognized that these recurring associations of pollen indicated different climatic phases in the northeast.

Davis(1958) presented these zones for the northeast in much more detail based on her studies. In general her zones fit the profile presented in this paper.

Davis's Zones	Type of Pollen
C-3	Hemlock, birch, oak, and chestnut maximum, followed by oak, pine and chestnut.
C-2	Hemlock minimum. Oak, pine, and hickory maximum.
C-1	Oak and hemlock maximum. Beech rising.
B-2	Pine maximum. Deciduous trees rising.
B-1	Rising pine. Larch, birch and alder maximum.
A-4	Spruce maximum.
A-3	Spruce minimum. Deciduous tree maximum, followed by a maximum of pine.
A-2	Spruce maximum.
A-1	Poplar and birch maximum. Herbs and shrubs decline, spruce rises.
T-3	Maximum of herbs, willow, alder and Juniperus-Thuja

From various general readings it has been found that oak is an indicator of warmth, pine is an indicator of dryness, hemlock is an indicator of moisture and spruce is an indicator of cold conditions.

Level Number	Zone	Glacial Event	Approximate Time	Climate	Pollen Indicators
1	<sup>a</sup> C-3			<sup>a and c</sup> Cool/moist	
2	C-2		<sup>b</sup> 2500 B.P.	Warm/dry	<sup>d</sup> Oak decreases/hemlock increases Oak maximum/hemlock minimum
3					
4	C-1			Warm/moist	Oak rising/hemlock maximum
5	B-2			Warm/dry	Pine replaces oak/hemlock minimum
6					
7	B-1		<sup>b</sup> 9000 B.P.	Warm	Rising pine
8		<sup>a and d</sup>			
9					
10	A-4	Valders Substage	<sup>a</sup> 11500 B.P.	Cool/dry	Oak minimum/hemlock minimum
11	A-3	Two Creeks Interstade		Warm/moist	Oak maximum/hemlock maximum
12	A-2	Valley Heads Substage	<sup>a</sup> 12500 B.P.	Cold	Spruce maximum
13					
14	A-1	Ark.-V.H. Interstade		Warm	Poplar and oak maximum
15					
16	T-3	Arkport Substage	<sup>d</sup> 15300 B.P.	Cold	Spruce maximum

Hypsithermal

Fig. 6 Profile Relationships

- <sup>a</sup> From Davis(1958).  
<sup>b</sup> From Deevey and Flint(1957).  
<sup>c</sup> From Deevey(1943).  
<sup>d</sup> Originates in this paper.

## Forest Development

The only part of New York State left unglaciated by the time the Valley Heads Substage receded was in the southwest part of the state. The mountains south of Salamanca (Fig. 3) were approached but never covered by ice. This unglaciated mountain region continues southward into Pennsylvania. This unglaciated region is called the Appalachian Refugium. It was forested and became the source of seeds for the forest that followed the retreat of the various ice fronts. Correlated data is indicated in Fig. 6.

Muller (personal communication, 1971) indicates that further work by Calkin and Muller may show a date around 14000 B.P. for the Valley Heads advance.

Evidently the spruce forest had reached the site by the time deposition started. Any initial nonarboreal trends before spruce forest development were obscured.

Levels 17- 20 Little pollen was found. Ogden (1965) points out that a kettle hole must first be cleared of stagnant ice before it can become a depositional basin. It is possible that the spruce forest developed at the site before the depositional basin was formed.

Level 16, T-3 The Arkport ice was present at the site perhaps 16000 years ago. At the time of the retreat of the initial cold period there was an open spruce forest with a large nonarboreal component. Oak and poplar were present with a few jack pine and maple trees at least within a few miles.

Level 14, A-1 The warming of the climate during the Arkport-Valley Heads Interstadial enabled oak and poplar to move onto the primitive soils near the site from the nearby Appalachian Refugium. During the 1000 year period it apparently became warm enough so that spruce could not compete as well. This gave oak and poplar the advantage.

Level 12, A-2 The Valley Heads Substage approached and moraine material was deposited within one mile of the site at a lower elevation. The cooling of the climate is shown by the reexpansion of the spruce forest at the expense of the poplar and oak. A spruce forest with mixed jack pine and oak was located at the site.

Level 11, A-3 The warm period during the Two Creeks Interstadial allowed the oak component to increase as the spruce component decreased. Evidently edaphic and climatic conditions were such that hemlock could move in from the Appalachian Refugium sixty miles to the southwest. A mixed oak, mixed white- jack pine, maple and hemlock forest with some spruce existed during this 1000 year period.

Level 10, A-4 At this point the Valders Substage was in the Erie- ontario basins and the climate was cooler. The decrease in the oak component indicated this cooler direction, while the decrease in hemlock indicated a dryer climate. The mixed pine component has increased. An oak- pine forest with some maple and hemlock existed at the site with a proportionately higher pine component.

Level 7, B-1 A rising white pine component is the main indicator of this zone. Decreasing oak is due to the pine naturally succeeding the oak, rather than being the result of climatic change(Wright, 1968). Both pine and oak can take the dryer conditions indicated by the decreasing hemlock component. B-1 is the starting point for the hypsithermal period of Deevey and Flint(1957), during which pollen data indicate a climate warmer than present. This warmer climate is supposed to last from B-1 through C-2 zones and approximates 9000-2500 B.P. in time. This is noted in Fig. 6.

Level 5, B-2 This is the result of processes started in B-1. A forest with a large white pine component with some oak and hemlock predominates.

Level 4, C-1 Here the climate became warmer. It also became moist enough so that hemlock and maple could increase. White pine was still the major component with oak, hemlock and maple present in moderate numbers.

Level 2, C-2 Very warm dry conditions existed. Oak was nearly able to replace pine; hemlock nearly became nonexistent. Maple was also able to compete with pine. An oak- maple forest existed on the site with a large nonarboreal component.

Level 1, C-3 A decrease in oak and an increase in hemlock is interpreted as indicating cooler, moister climate. Increased percentages of nonarboreal pollen, particularly ragweed and the Chenopods, indicate disturbance of the land by fire or agriculture(Wright, 1968). A mixed deciduous forest with

some white pine and hemlock was present. This compares with Braun's(1959) classification of the present vegetation.

### Further Discussion

Each collection site in New York State was unique. Some were lakes, some were bogs, and some were swamps. Gehris'(1971) site was a drainage channel for a periglacial lake. Yeager's(1969) study was from a kettle hole that looks like a kettle hole. The present study site is assumed to be a completely filled kettle hole.

With the exception of the Gehris(1971) study and the present study, all nontruncated late pleistocene profiles from New York State fit the general A-B-C zones of Deevey (1943). The author feels they correspond with Valders time and after. The Gehris(1971) study started at Valley Heads time. The present study started 1000 years before Valley Heads.

Yeager(1969) discussed some of the features that New York State profiles have in common. Yeager points to a three phased hemlock hardwood period which followed the decline in pine; pine(B-2) declines as hemlock(C-1) rises; hemlock declines as Fagus and Carya rise(C-1); hemlock rises to a new maximum(C-3). Obvious differences exist between the present study and others in New York State. For example the C-2 zone in this study is represented by an oak maximum. Fagus is not a component and Carya is only slightly represented.

Yeager's(1969) carbon date of 6940 B.P. for the bottom of his C-1 zone and his date of 2830 B.P. for the upper part of his C-2 zone would fit well in Fig. 6 of this study. Gehris'(1971) zones in general fit the pattern found in this study also.

Each site sits at a different latitude and altitude. Each was subjected to a different series of glacial stresses. Each site was a unique distance from the source of new flora (Appalachian Refugium). Disagreement in pollen percentages at different levels should be expected and was present. Enough agreement exists though so that one study does not invalidate another.

#### Concluding Statement

This study has many unique features. The carbon date and pollen profile interpretation support Connally's(1961) designation of the Arkport moraine. This is the only pollen study to indicate a pre-Valley Heads, post-Binghamton(Kent) ice advance in Western New York. Muller(personal communication, 1971) has indicated that it may simply represent a slight preadvance of the main Valley Heads Substage instead of representing a separate substage.

The carbon date of 15300 B.P. is the earliest late-Pleistocene date for a Valley Heads associated event on the Allegheny Plateau. The spruce- oak association in the lower



levels has seldom been validated by macrofossils (spruce cones-oak wood). This site is substantially higher in elevation than any other New York State collection site (most are below 1300 feet). The site stands 475 feet higher in altitude than Valley Heads moraine. The lack of a spruce peak at Valdres time is also unusual.

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